SPINNING QUALITY OF COTTON GLEANED FROM THE GROUND BY MACHINE

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Spinning Quality of Cotton Gleaned From the Ground by Machine

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SUMMARY AND CONCLUSIONS

The quality and spinning performance of Acala 4-42 variety cotton mechanically reclaimed from the ground was evaluated from a single field in the San Joaquin Valley of California in 1965. The test compared the lint and yarn qualities of three sources of cotton: (1) First pick with a spindle picker when 75 to 85 percent of the bolls were open; (2) second pick with the same machine 35 days later; and (3) gleaning with a notched belt gleaner 3 months after first pick.

The seed cotton for the study was harvested from a normally farmed field near Arvin, Calif. The cotton for first and second picking was stored and ginned at the same time as the gleaned cotton in a typical commercial gin with moderate overhead cleaning and two stages of lint cleaning. The lint used in this study was processed at the Textile Research Laboratories, Texas Technological College, Lubbock, under contract with Market Quality Research Division (MQRD), Agricultural Research Service, Clemson, S.C.

The lint from the second pick was finer and had a lower light reflectance, more trash, and a larger percentage of short fibers than first-pick cotton. However, within the accuracy of the measurements, the yarn quality was essentially equal to first pick except for a slightly higher break factor. No differences were detected between the two spindle harvesting treatments in processing efficiency including ends down during spinning.

Lint obtained from the gleaned cotton was inferior in every measure to the first pick and almost inferior in every measure to second pick. The market grade was "good ordinary" as compared with "middling" and "strict low middling" for first and second pick. The short fiber content was essentially the same as second pick, and the fiber was slightly more coarse than the second pick. The lint from gleaned cotton was considerably weaker, less uniform in length, more yellow and lower in reflectance, and contained more trash. In the card web, the gleaned cotton produced 50 percent more neps.

Yarn spun from gleaned cotton was only 78 percent as strong as yarn from the earlier machine-harvested cotton. The appearance index was 83 as compared with 108 for first pick. The yarn had 4½ times more neps, 4¼ times more thick places, and 3¾ times more low places than the mean of the first and second pick.

The processing efficiency was drastically reduced for gleaned cotton compared with machine-picked cotton. The ginning rate was only 75 percent as fast as for picked cotton, and the gin turnout was reduced from a normal 32 to 22 percent. In the spinning mill, the picker loss was three times as great and the card loss was two times as great for gleaned cotton as for picked cotton. The ends down during spinning increased from a range of 12 to 13 for picked cotton to 112 for gleaned cotton or about ninefold.

Based on the data from this single test, the lint from gleaned cotton is inferior and produces a low-quality yarn as compared with normal machine-picked cotton. Considerable caution should be exercised in interpreting these data as being indicative of the quality characteristics of all gleaned cotton. The degree of fiber deterioration and the amount of foreign matter in gleaned cotton would be expected to be related to the length of time the seed cotton was on the ground, the temperature of the soil and air, the moisture content of the soil, and the amount of rain and fog. In 1965, the cotton gleaned for this study had

been subjected to fog and rains for at least 60 days. During an "average" year there would be less fog and rain during the harvest period, and gleaning would have occurred 20 to 30 days earlier.

INTRODUCTION

More than 95 percent of the cotton produced in three Western States is harvested with spindle-type mechanical pickers. During 1961 to 1965, the three Western cotton-growing States—California, Arizona, and New Mexico—produced an average of 2,858,000 bales per year. About 130,000 bales per year or 4.6 percent was gleaned from the ground. Gleaning decreased from 1966 to 1968, yet it still averaged over 3 percent or more than 61,000 bales per year.

A number of studies have shown the relationship between the quality of handpicked and spindle machine-picked cotton. Before 1965 there were no spinning evaluation studies to establish the relative quality of gleaned cotton. The decision by farmers to buy and operate gleaning machines or to contract for gleaning was based on economics as measured by the market grade of the bale, primarily color and trash, and by the direct operating costs. Because the bales harvested by gleaning were not separated or marked, there was no direct method of determining the relative quality or the effect of a large number of gleaned cotton bales on the industry.

Gleaned cotton describes the method of harvesting, not a quality of cotton. In general, gleaned cotton includes weather-shattered cotton dropped before harvest, cotton dropped by the pickers, and diseased, insect damaged, immature, or tight locks shattered by weather or machines. A small proportion of gleaned cotton is harvested soon after first picking.

With no adverse weather, this gleaned cotton includes a large percentage of the same quality cotton as first picked. However, the majority of gleaned cotton in the Far West is left on the ground for 30 to 90 days, and with various weather conditions and traffic, should show varying degrees of fiber deterioration and amounts of foreign matter. This report is concerned with the quality of gleaned cotton that has been on the ground for more than an average time.

Since 1960, several gleaning machines have come into use. Various methods of reclaiming cotton from or near the soil surface are used: Saw cylinders, brushes, air nozzles, fingers, and notched belts. Some early models provided no seed cotton cleaning, and generally the material taken to the gin was less than 50 percent seed cotton. The use of these gleaners was limited primarily by problems in ginning. Recently, various cleaning equipment and combinations of cleaners have been added to the basic gleaning machine. Because of improvements in cleaning, ginners are less reluctant to accept gleaned cotton.

OBJECTIVES

The objective of this research was to determine the relative quality of cotton gleaned from the ground with a notched-belt machine, equipped with seed cotton cleaning machinery, 60 to 90 days after first pick, and after rains as compared with first- and second-pick cotton.

PROCEDURE

Equipment

Machine-picked cotton was harvested with a 1-year-old straight-spindle machine equipped with square spindles. Picking heads were mounted in tandem or the normal one-row configuration. The machine was in excellent mechanical condition and was adjusted and operated according to manufacturer's recommendations. The compressor sheets were adjusted with low pressure and minimum spindle clearance for high-quality first harvest. The pressure was increased for the second harvest.

A new two-row notched belt gleaner was used to obtain the ground-harvested cotton. The gleaner was equipped with all the standard cleaning equipment offered by the manufacture including three sets of notched belts, an auger-type seed cotton cleaner, and an air-grate cleaner on top of the basket. The machine was adjusted by a representative of the cooperating farmer and operated at approximately 3.5 m.p.h. The test cotton was obtained from the first pass of the gleaner.

Field

The test cotton was obtained from an 80-acre field of Acala 4-42 variety cotton at Arvin. The field was planted in a skip-row pattern with two rows of cotton and one row unplanted. During the growing season, the field had been managed for maximum production with high rates of fertilizer and late irrigation. The field was defoliated on October 5 with 3 pounds per acre of magnesium chlorate. At the time of first harvest, the plants were between 46 and 50 inches in height, 80 to 85 percent lodged, with variable defoliation ranging from 45 to 60 percent. The yield varied between 2½ and 3½ bales per acre.

The first harvesting lots were obtained October 18 between 11:00 a.m. and 6:00 p.m. The field was divided into four sections, and the test cotton was obtained from the center rows. Each lot was weighed, placed into separate trailers, and transported to the gin. The cotton was transferred from the field trailers into special storage baskets and placed under a roof. Thermocouples were placed in each basket, and temperature measurements were recorded every 2 minutes throughout the storage time.

After approximately 1 inch of rain, the second harvest lots were picked on November 23. The procedure was similar to the first harvest date except no thermocouples were placed in the storage baskets. Because heating had not occurred in the baskets of first-pick cotton, and because second-pick cotton was below 11 percent moisture content, there was little reason to suspect heating in the second-pick lots.

Rain and fog characterized all of December and early January. Little or no cotton was gleaned during this period by any farmer. Between January 11 and 25, and only during the driest parts of the days, the four areas in the field were gleaned and placed in separate baskets.

Ginning

The objectives of these tests did not require that variation in ginning be included. However, it was necessary that the cotton be ginned alike and that good ginning practices be used. The common practice for gin operators in this area is to either hold ground-harvested cotton until near the end of the season where only one gin is available or to use one gin of a multiple gin facility for high moisture or high trash content seed cotton or both. A gin facility with two separate gins near the test field was chosen for this study. The two gins were almost identical.

The ginning equipment for the machine-picked cotton consisted of two driers operating at 180° F.; a six-cylinder inclined cleaner; two seven-cyclinder inclined cleaners; five gin stands; and two stages of saw-type lint cleaners. The ground-harvested cotton was ginned on the other gin located on the same gin yard. The ginning equipment was as near comparable as was possible, except that the drying temperature was 200° F. and was equipped with an additional green leaf and stick machine, and the plant had only four gin stands.

Processing and Testing

The processing was done by Textile Research Laboratories under a research contract with MQRD.

Each bale was delivered to the opening room where the bagging and ties were removed. The bales were conditioned for 24 hours before being processed through opening and picking equipment.

All lots were processed separately from opening through spinning using the following organization:

Opening and picking	14-oz. lap
Carding (10 lb./hr. with 320-lb. pressure on the crusher rolls)	50-grain sliver
Two processes of drawing:	
Breaker (8 ends up)	53-grain sliver
Finisher (8 ends up)	55-grain sliver
Roving	1.25 hank (1.15 T.M.)
Spinning (single creel)	40s yarn (3.75 T.M.) (5,760 spindle-hour test)

Fiber test samples were taken when each bale was opened. All tests (fiber and yarn) were performed under standard atmospheric conditions (70° F. and 65-percent r.h.).

All processing was performed under controlled atmospheric conditions. New travelers were used for each spinning lot or doff of yarn. The spinning frames were run for 30 minutes to break in travelers and for obtaining enough yarn for trial sizing. End breakage was recorded at 15-minute intervals during the spinning of each lot.

RESULTS

Foreign Matter and Moisture

The seed cotton trash content of the machine-picked cotton as it entered the gin was essentially the same for first- and second-pick cotton (table 1). The values of 9.1 and 8.3, respectively, are in the upper portion of the normal trash content range. The trash content of the gleaned cotton was 39.3 percent or four times as great as machine-picked cotton. After passing through the seed cotton cleaning equipment, the trash content (12.1 percent) of the gleaned cotton was still greater than the initial trash content of machine-picked cotton. The overhead cleaning removed approximately the same proportion of trash for first picking and gleaning. The trash in the second-pick cotton apparently was more difficult to remove as only 70.5 percent of the initial trash was removed compared to 83.2 and 78.5 percent for first-picked and gleaned cotton.

The foreign matter in the ginned lint was the greatest in the gleaned cotton or 4.26 percent as compared with 1.4 percent for the second pick and 1.04 percent for the first pick.

The seed cotton moisture of the lots as they entered the gin was lowest for first picking and highest for gleaning. The seed moisture content was approximately the same for all lots; therefore, the moisture differences among lots were primarily in lint and trash. The lint moisture samples from the wagon and gin lint slide confirm that the moisture variability was mostly in the lint (table 1). Because all the test lots were harvested at different times and stored before ginning, the moisture differences cannot be used to characterize harvesting methods. However, the data are reported to provide a record of conditions of the test lots before and after ginning.

Lint Quality

The bales from all three treatments were within the "premium" fineness range of 3.5 to 4.9 (table 2). The micronaire range of first-pick cotton was 4.3 and dropped to 3.5 for second pick. Because the largest proportion of the seed cotton on the ground was produced during the same period as the first-pick seed cotton, the micronaire for the gleaned cotton was predicted to be closer to that

TABLE 1.—*Trash and moisture content of test cotton before spinning*

[NS, not significant]

Property of test cotton	Treatment means			Standard error of a mean, $S_{\bar{x}}$	Significant differences at the 95-percent confidence level
	1st pick (A)	2d pick (B)	Gleaning (C)		
	Percent	*Percent*	*Percent*		
Seed cotton trash:					
Wagon sample	9.1	8.3	39.3	1.0	C>A,B
Feeder sample	1.7	2.6	12.1	.3	C>A,B
Trash removed	83.2	70.5	78.5	1.6	A,C>B
Seed cotton moisture:					
Wagon sample	9.6	10.5	12.1	.2	C>B>A
Lint moisture:					
Wagon sample	8.07	8.77	9.55	.27	C>A,B
Lint slide sample	4.30	4.85	5.87	.15	C>B>A
Lint trash:					
Lint slide sample	1.04	1.47	4.26	.22	C>A,B
Seed moisture:					
Gin stand sample	9.41	10.43	10.23	.35	NS

TABLE 2.— *Quality of lint delivered in pilot spinning plant*
[NS, not significant; MID, middling; SLM, strict low middling; GO, good ordinary]

Property and method of measure	Treatment means			Standard error of a mean, $S_{\bar{x}}$	Significant differences at the 95-percent confidence level
	1st pick (A)	2d pick (B)	Gleaning (C)		
Fineness:					
Micronaire ----------μg/in--	4.3	3.5	3.6	0.03	A>C>B
Strength:					
Pressley[1] ----------p.s.i. × 1,000[1]--	90.8	92.6	84.0	1.1	A,B>C
Stelometer ----------grams/tex---	25.1	25.2	22.2	.2	A,B>C
Elongation:					
Stelometer ----------percent--	6.0	5.4	6.2	.1	A,C>B
Length:					
Fibrograph ----------inches--	1.08	1.08	1.07	.01	NS
Classers' length ----------do--	1 1/16	1 1/16	1 1/16	--	NS
Uniformity ratio:					
Fibrograph ----------percent--	47	47	44	.3	A,B>C
Short fiber content ----------do--	4.6	9.1	10.6	.5	B,C>A
Market grade:					
Classing office ----------designation--	MID	SLM[2]	GO[3]	--	----

[1] "0" gage.
[2] Three bales strict low middling, one bale strict middling.
[3] Reduced from strict good ordinary because of bark.

of first pick than that of second pick. However, the fineness of the gleaned cotton was closer to that of second pick, indicating some deterioration.

The fiber strength of both first- and second-pick cotton was between 91,000 to 93,000 p.s.i. The strength of gleaned cotton, 84,000 p.s.i., indicates deterioration. Similarly, the strength as indicated by the stelometer was greatly reduced for gleaned cotton. The fiber elongation data obtained with the stelometer show a different relationship among treatments; second-pick cotton was lower than first-pick or gleaned cotton.

No differences could be shown among the treatment mean values for fiber length. All lots were classed at 1-1/16 with the fibergraph data ranging from 1.07 to 1.08. However, the gleaned cotton and second-pick cotton had a greater proportion of short fibers, 10.6 and 9.1 percent, respectively, as compared with 4.6 percent for the first-pick cotton. The uniformity ratio was 47 percent for first and second pick and 44 percent for gleaned cotton.

The market grades assigned by the classing office were "middling" for first pick, "strict low middling" for second pick, and "good ordinary" for gleaned. The gleaned cotton was reduced from "strict good ordinary" because of excessive bark.

All the measurements made on lint quality in the card web showed drastic reduction in quality for gleaned cotton (table 3). The nonlint content was twice as high for gleaned cotton as for the two machine-picked treatments.

The reflectance of the cleaned lint as measured with a colorimeter decreased with the amount of time the seed cotton was left in the field. The difference between the reflectance of gleaned cotton (65.4 percent) and second-pick cotton (77.2 percent) was greater than between first- and second-pick cotton, which again indicated the accelerated deterioration of cot

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TABLE 3.—*Nonlint content and color of lint before and after use of Shirley Analyzer*

Property of lint	Treatment means			Standard error of a mean, $S_{\bar{x}}$	Significant differences at the 95-percent confidence level
	1st pick (A)	2d pick (B)	Gleaning (C)		
Nonlint content:					
Shirley analyses ----------percent--	0.53	0.78	1.55	0.06	C>A,B
Color before Shirley analyses:					
Reflectance ----------do--	79.0	77.3	65.7	.2	A>B>C
Yellowness ----------+b[1]--	8.7	8.6	9.0	.1	C>A,B
Color after Shirley analyses:					
Reflectance ----------percent--	78.8	77.2	65.4	.1	A>B>C
Yellowness ----------+b[1]--	8.1	8.1	8.5	.1	C>A,B

[1] Values from b scale of Nickerson-Hunter Cotton Colorimeter.

TABLE 4.—*Quality of yarn*

[NS, not significant]

Property of yarn	Treatment means			Standard error of a mean, $S_{\bar{x}}$	Significant differences at the 95-percent confidence level
	1st pick (A)	2d pick (B)	Gleaning (C)		
Actual yarn ----------number--	41.21	40.84	40.41	0.38	NS
Corrected break factor ----------units--	2,499	2,565	1,966	18.0	B>A>C
Appearance ----------index--	107.5	97.5	82.5	3.7	A,B>C
Irregularities (C.V.[1]) ----------percent--	21.90	21.68	25.34	.36	C>A,B
Neps per 1,000 yards ----------number--	16.9	19.2	84.0	4.5	C>A,B
Thick places per 1,000 yards -------do--	18	18	77	5	C>A,B
Low places per 1,000 yards --------do--	52	46	130	10	C>A,B

[1] Coefficient of variability.

increased 3½ percent, the number of thick places by a factor of 4, the low places by a factor of 3, and the number of neps by a factor of 4 for yarn from gleaned cotton compared to machine-picked cotton. The yarn appearance index was rated as 82 for gleaned cotton as compared with 108 and 98 for first and second pick.

Processing Efficiency

The production cost factors that were measured all show that gleaned cotton would be predicted to substantially increase costs (table 5).

The ginning speed (time to produce a bale of lint) was reduced by 25 percent with gleaned cotton. In addition, the gin must handle 50 percent more material (table 1) to make a bale of clean lint with a resulting "gin turnout" of 22 percent as compared with 31 to 32 percent for machine-harvested cotton.

The losses during mill processing were at least double for gleaned cotton compared with machine-picked cotton. The picker loss was 2.2 percent for gleaned, and 0.7 and 1.1 percent for first and second pick. The card loss was increased from 4.08 and 4.74 for first and second pick to 8.41 for gleaned. The number of neps was nearly double for the gleaned cotton.

The most dramatic change in any measured value for the treatments was the number of ends down. Breakage was increased from 12 EDMSH (ends down per thousand spindle hours) for first-pick cotton to 112 EDMSH for gleaned cotton. The difference between first- and second-pick cotton was less than the experimental error.

TABLE 5.—*Processing efficiency*

Efficiency factor	Treatment means			Standard error of a mean, $S\bar{x}$	Significant differences at the 95-percent confidence level
	1st pick (A)	2d pick (B)	Gleaning (C)		
Gin:					
Ginning speed ----------lb. lint/min.--	67.6	69.9	51.9	3.4	A,B>C
Gin turnout ----------percent--	32.3	30.8	[1]21.8	---	---
Mill:					
Picker loss ----------do--	.70	1.07	2.19	.31	C>A,B
Picker machine efficiency ---------do--	.10	.18	.35	.05	C>A,B
Card loss ----------do--	4.08	4.74	8.41	.18	C>A,B
Neps per 100 square inches --number--	3.5	3.6	5.4	.4	C>A,B
Ends down (EDMSH) ----------do--	12.46	13.72	112.46	5.76	C>A,B

[1] Replications 1, 2, 3 bulked.

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